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Compliance with Standard Precautions Among Nurses in Buraidah Health Care Settings. Buraidah, Saudi Arabia

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Abstract: This study was designed to determine the knowledge, compliance, and self-efficacy of standard precautions among nurses in Buraidah healthcare settings in Saudi Arabia. A cross-sectional study was conducted among 420 qualified nurses with over one year of working experience in the selected health setting. A structured self-administered questionnaire was used for data collection, including sections related to knowledge, compliance, and self-efficacy on standard precautions. Regression analysis was used to identify factors related to achieving a good level of compliance. A high rate of a good level of compliance with standard precaution (95%) was reported in this study, followed by good knowledge (73.8%) and good self-efficacy (44.8%). Factors related to education levels such as those holding a bachelor certificate or above (AOR = 6.145, 95% CI = 3.105-12.161, p = <.0001), with experiences more than 5 years, working in a less contaminated environment, being of technical title as nurses and working in public hospitals (OR = 2.885, 95% CI = 1.230-6.767, p = .015), were found highly associated with a good level of knowledge, compliance and self-efficacy of standard precaution ($p<0.05$). Compliance with standard precautions among the nurses was good, however, best practices for strict adherence to the standard precautions are required as the core for ensuring good healthcare quality and an adequate safe working environment. Continuous orientation and training programs are required to achieve better improvement of SP measures.

Keywords: Compliance, Standard Precaution, Nurses, Self-Efficacy, Knowledge

Introduction

Standard Precautions (SP) are a set of infection control practices used to prevent the transmission of diseases that can be acquired by contact with blood, body fluids, non-intact skin, and mucous membranes (Borlaug, 2015; Boyce and Pittet, 2002). Basic infection control practices are compulsory precautions for anyone in any healthcare facility to reduce the Health Care-Associated Infections (HCAIs) which are dominant in many healthcare services (Vaz *et al*., 2010). Besides that, the risk for front-line Healthcare Workers (HCW) increased as they were exposed to patients with diagnosed infectious diseases, such COVID-19 as an example (Nguyen *et al*., 2020). Nurses may acquire an infection during the provision of nursing care because of occupational exposure to microorganisms. Relevant literature, elsewhere, reports that nurses' compliance with SPs is low (Kosgeroglu *et al*., 2004). Additionally, high rates of exposure to microorganisms among nurses via several modes (needle sticks, hand contamination with blood, exposure to air-transmitted microorganisms) occur (Efstathiou *et al*., 2011). Therefore, regulative and supportive measures must be put into place to ensure compliance with infection control policies in the workplace at all times (Bandyopadhyay *et al*., 2020). Moreover, the Centers for Disease Control and Prevention (CDC), described the importance of adherence to infection prevention and control practices as an essential element to providing safe and high-quality patient care across all settings where healthcare is delivered (CDC, 2020).

Knowledge of SP and it is a practice among HCPs, in general, is crucial to avoid transmission of HCAIs and to avoid being a victim of such infection and its complications. Moreover, compliance with infection control practices should be associated with adequate knowledge including guidelines and good training. Many studies show that low knowledge of basic concepts of SP could directly reflect the low level of practice and consequently affect the quality of patient care (Abubakar *et al*., 2015; Mashoto *et al*., 2015;

Timilshina *et al*., 2011). Therefore, good knowledge of the nature of the SP and the strict implications of this knowledge in practice including lessons on isolation precautions are the main elements to prevent the transmission of infectious agents in healthcare settings and reduce the prevalence of healthcare-associated infections (Oksanen *et al*., 2021; Rutala and Weber, 2008).

On the other hand, evidence illustrated a strong association between the adequacy of the use of Personal Protective Equipment (PPE) and the rate of cross-infections in healthcare settings (Sodhi *et al*., 2013). That means, ensuring proper selection and use of PPE based on the nature of the patient interaction and the potential for exposure of the HCW to the infective agents is likely related to the strong practice of the PS and adequate related knowledge (Moura *et al*., 2021).

Nurses play an important role in the prevention and control of hospital infections because they undertake a high proportion of the treatment and care of patients and thus show a significant level of standard precautions compliance (Luo *et al*., 2010). Accordingly, Some Health Belief Models (HBM) were used to identify the factors that can improve the likelihood of compliance (Glanz and Bishop, 2010). Most health behavior theories suggest the most proximal factors influencing and impacting compliance with the standard precautions include: Standard precautions training and knowledge, hospital grade, general self-efficacy, exposure to patients and the department in which the nurse works (Cheung *et al*., 2015; Efstathiou *et al*., 2011). Almost all those factors were included in this study as predictors for nurses' standard precautions compliance in their daily practice. Several research works have also provided strong support for the relationship between self-efficacy and outcome expectations and behavior change (Okuboyejo *et al*., 2018). They described people with high self-efficacy were more likely to engage in certain positive behaviors when they believed they could execute those behaviors successfully.

In Saudi Arabia, the ministry of health has recognized the importance of HCAIs as part of the quality of the healthcare system in the country. Many studies have been conducted in this field showing a gap in the health services and the required health measures to control the HCAIs (Abolfotouh *et al*., 2017; Colet *et al*., 2017). Transmission of MERS-CoV infection in Saudi Arabia in the period 2012-2017 and particularly in the year 2016 was a disaster in the country and affected the healthcare workers in many hospitals (Alfahan *et al*., 2016). Since the time of MERS-CoV, or after the last pandemic of COVID-19, the ministry of health in the country has developed a series of guidelines and instructions as part of the different control activities to enhance healthcare workers to adhere to the required level of compliance with standard precautions among the healthcare workers that will lead to control infections in the healthcare settings in the country (MOH, 2014). A recent study in Saudi Arabia (Al-Kharj Hospital), reported a rate of 0.43% of the HAIs among the total patient admission with a higher rate of central line-associated bloodstream infections (1.15/1000 central line days) (Ahmed *et al*., 2021). The latter was followed by others such as catheter-associated urinary tract infections, ventilator-associated pneumonia, and surgical site infections. However, another study conducted by Alshamrani *et al*. (2019), reported an overall point prevalence of HCAIs was 6.8% and the most common types of infections were pneumonia (27.2%), urinary tract infections (20.2%), bloodstream infections (10.5%) (Alshamrani *et al*., 2019).

Among the healthcare workers, nurses were more likely to become infected in their healthcare settings. Some authors refer to the inadequate knowledge of infection control practices among nurses in comparison to other patient care staff in the same services as reported recently for the COVID-19 infection (Bandyopadhyay *et al*., 2020; Sabetian *et al*., 2021). Thus, better containment among clinical nurses can be attributed to strict safety training and compliance with preventative measures which are recommended to be implemented across all settings (Al-Kuwari *et al*., 2021). Therefore, this study focused on nurses as an important element of the healthcare workers who receive less attention in many healthcare settings including Saudi Arabia. The objective of this study was to assess knowledge, level of compliance, self-efficacy, and associated factors with the standard precautions among nurses in Buraidah healthcare settings in Saudi Arabia.

Materials and Methods

Study Setting and Sample

This was a cross-sectional study conducted on the standard precaution for infection control among qualified nurses in clinical departments of the selected healthcare settings in Buraidah City. Buraidah city is located in the central area of Qassim with a total population of 614,093 (SC, 2022). The city constitutes significant numbers of health care facilities including 44 primary health care centers and referral hospitals. The study was conducted in 5 health institutions in the Buraidah region (King Fahad Specialist Hospital, Buraidah Central Hospital and Maternal and Child Hospital, Sulaiman Alhabib Hospital, and National Qassim Hospital) and 10 primary health care centers.

Inclusion criteria: All registered nurses in clinical departments of the selected healthcare settings in Buraidah city.

Exclusion criteria: Non-medical employees, and other health care providers except nurses were excluded from the study.

The sample size was determined using a single population proportion formula considering the following assumptions: 95% confidence interval, 5% margin of error, 50% proportion (since there was no previous study), and 10% non-response rate. The final sample size of 420 nurses was divided into two main groups: 300 from the six main hospitals (around 60 enrolled participants from 4 public hospitals and 30 from 2 private hospitals) and 120 participants from eight primary healthcare centers. In the primary health care facilities, 120 participants were enrolled from the major four centers (20 participants for each) and the remaining from the other 4 centers (10 for each). A random selection was performed to include the required number of participants from each nominated healthcare setting. The study was conducted from 1st May to 30th August 2018.

Measurement and Data Collection

A structured self-administered questionnaire (English language) externally validated by Luo *et al*. (2010) was used in this study, however, some minor modification was done to adopt the local context of Saudi Arabia. The scientific credibility and validity of the tool, it was evaluated by three independent public health preventive medicine experts, who provided feedback on the accuracy, relevance, and simplicity of the included questions and statements. The questionnaire was pretested using 5% of the sample (25 nurses from another hospital in Riyadh city) and the final Arabic version was reviewed and approved by the research team. A calculated Cronbach alpha of more than 0.72, was obtained from the overall domains, however, each domain was tested to assess the internal consistency of the questions. The questionnaire was distributed to those participants who agreed to be enrolled in the study and accordingly, each participant signed written consent.

Study Variables

The questionnaires consisted of three parts. Part, one includes Variables related to sociodemographic characteristics such as age, sex, marital status, job category, work experience, and assigned place. Part two consists of 20 items pertaining to knowledge about standard precautions, mainly those related to the basic concepts, content, and activity requirements of the standard precautions; compliance with standard precautions such as those related to identifying the level and conditions for washing hands, wearing a face mask, wearing a protective eye patch and goggle, wearing a protective suit, protective cap or shoe shade in the operation, final managing of the second-hand syringe, or second-hand sharps. Part three includes 10 items related to self-efficacy toward compliance with standard precautions. The 10 items describe the way to solve the problem if found, the ability to achieve the goal, the level of being done effectively and according to personal abilities, personal effort, as well as to look for the suitable solution to the problem. In addition, it reflects the general confidence or self-confidence showing how nurses could cope when they are faced with new experiences or dealing with changeable environments.

The outcome variable of the study was healthcare workers' compliance with standard precautions (always compliant).

The responses to the questions related to knowledge were either 'yes', 'no', or 'unknown'. 'Yes' is given a value of 1 point and 'no' or 'unknown' 0 points; the maximum possible score is 20 and the minimum accepted score is over 12 (60%) as a cut-off point to identify the level of goodness (joining good and moderate), as modified from Bloom's cut-off point (considered good if the score was between 80 and 100%, moderate if the score was between 60 and 79% and poor if the score was less than 60%). Bloom *et al*. (1956) The higher the score, the greater the knowledge about standard precautions the participant has. On the other hand, compliance with standard precautions and self-efficacy questions were measured with a Likert scale of 0-4 points: 0 = never, 1 = seldom, 2 = sometimes, 3 = usually, and 4 = always, giving a score range of 0-60. The higher the score (≥45 = 75 percentile) as a cut-off point, the better that person carries out the standard precautions. Amin *et al*. (2013) At the beginning of the analysis, those who reported that they were always compliant were taken as "compliant" and those who reported that they were sometimes and seldom compliant were taken as "non-compliant." Next, a summation of the 20 compliance items was made. Then, the variable was recoded and dichotomized as compliant/ non-compliant. More likely, the same procedure was followed in the analysis of self-efficacy, and the 75 percentile was considered the cut-off point for the level of goodness scale.

The nine departments mentioned in Table 1, were further categorized into two; those named as less contaminated such as internal medicine, outpatient, infection control unit, and primary health care units. For the highly contaminated areas include an emergency room, intensive care unit, surgery departments, operation rooms, and haemodialysis units. Usually, the less contaminated settings are considered because of less exposure or no exposure to contamination sources and the use of personal protective equipment (Power minimum, while the contamination sources are those where nurses and other healthcare workers were of great exposure to the source of infection, surgical site infection, or those areas in health-care facilities that require special ventilation. (Chinn and Sehulster, 2003).

Table 1: Socio-demographic characteristics of the participants

Variables	Categories	No.	%
Age category	<30 years	164	39.0
	30-39 years	204	48.6
	≥40 years	52	12.4
Educational level	Diploma	108	25.7
	High diploma	55	13.1
	Bachelor and above	257	61.2
Technical title	Nurse	259	61.7
	Nurses' practitioner	76	18.1
	Nurse in-charge	85	20.2
Department	Internal Medicine	67	16.0
	Emergency	66	15.7
	Intensive Care Unit (ICU)	64	15.2
	Surgery	39	9.3
	Outpatient	32	7.6
	Haemodialysis	13	3.1
	Infection control	10	2.4
	Operation room	9	2.1
	Other in primary health care	120	28.6
Working place	Public hospital	240	57.1
	Primary health care	120	28.6
	Private hospital	60	14.3
	<5 years	131	31.2
Years of experience	5-9 years	203	48.3
	≥10 years	86	20.5

Statistical Analysis

All the data were entered into Statistical Package for the Social Sciences (SPSS) version 20 (SPSS, 2020) for data analysis. Descriptive and inferential statistics were carried out to describe the characteristics of the study sample illustrating the frequency and percentage of the study variables which include frequency, percentage, mean, and Standard Deviation (SD). Bivariate analysis using the Chi-square test was done to examine the relationships between categorical variables such as a satisfactory level of knowledge on standard precaution (inadequate or adequate), level of compliance (compliance or non-compliance), and self-efficacy level. Exposure variables having a p-value <0.05 level of significance in bivariate analysis were entered to construct the final model of multivariate logistic regression analysis to identify the predictive variables having a significant association with the standard precautions' compliance. The Odds Ratio (OR) and confidence interval (95%CI) were presented with the p-value set at <0.05.

Ethical Considerations

This study was approved by the scientific committee at the public health and health informatics college and by the IRB at King Abdullah International Medical Research Centre with reference number SP18/050/R. All participants were provided with informed consent and a brief description of the project's aim was given. In addition, they were informed to leave the questionnaire anonymous without any identifiers or personal information. Privacy and confidentiality were completely protected.

Results

Respondents' Characteristics

In total 420 nurses were enrolled in the study, the majority (n = 204 or 48.6%) were aged between 30-39 years, with a bachelor's degree or above (n = 257 or 61.2%), certified nurses (n = 259 or 61.7%) and with working experience of more than 5 years (n = 289 or 68.8%), as illustrated in Table 1.

According to the dichotomies scores of the summative answers, the level of goodness was used to stratify each of the three main domains: Knowledge, compliance with standard precaution, and self-efficacy. Findings illustrated an overall moderate goodness level of knowledge (73.8%), high for compliance with standard precaution (95%), but very low for the rate of self-efficacy (44.8%).

Levels of Knowledge Compliance and Self-Efficacy

Table 2 demonstrates the association between the sociodemographic characteristics of the participants and their level of knowledge, compliance, and self-efficacy. There were significant differences in the percentage of good knowledge, found across four variables such as education level (holding a bachelor's certificate or above), nurses with experiences >5 years, working in a less contaminated environment, and working in a public hospital, with a p-value <0.05.

Table 2: Association between demographic variables and knowledge, compliance, and self-efficacy on standard precautions

		Knowledge*			Compliance**			Self-efficacy**		
Variables	Categories	Inadequate No. (%)	Adequate No. (%)	p-value	Inadequate No. (%)	Adequate No. (%)	p-value	Inadequate No. (%)	Adequate No. (%)	p-value
Age category	<30 years	50 (45.5)	114 (36.8)	.276	34 (41.5)	130 (38.5)	.8450	90 (38.8)	74 (39.4)	.0820
	30-39 years	48 (43.6)	156 (50.3)		39 (47.6)	165 (48.8)		106 (45.7)	98 (52.1)	
	>40 years	12 (10.9)	40 (12.9)		9 (11.0)	43 (12.7)		36 (15.5)	16 (8.5)	
Educational level	Diploma	32 (29.1)	76 (24.5)	.000	25 (30.5)	83 (24.6)	<.0001	81 (34.9)	27 (14.4)	<.0001
	High diploma	27 (24.5)	28 (9.0)		24 (29.3)	31 (9.2)		32 (13.8)	23 (12.2)	
	Bachelor	5 (46.4)	206(66.5)		33 (40.2)	224 (66.3)		119 (51.3)	138(73.4)	
Technical title	Nurse	69 (62.7)	190 (61.3)	.811	48 (58.5)	211 (62.4)	0.0180	145 (62.5)	114 (60.6)	.5770
	Practitioner nurses	21 (19.1)	55 (17.7)		23 (28.0)	53 (15.7)		38 (16.4)	38 (20.2)	
	Nurse in-charge	20 (18.2)	65 (21.0)		11 (13.4)	74 (21.9)		49 (21.1)	36 (19.1)	
Experience	< 5 years	40 (36.4)	91 (29.4)	.011	30 (36.6)	101 (29.9)	.1700	71 (30.6)	60 (31.9)	.9590
	5-9 years	40 (36.4)	163 (52.6)		32 (39.0)	171 (50.6)		113 (48.7)	90 (47.9)	
	>10 years	30 (27.3)	56 (18.1)		20 (24.4)	66 (19.5)		48 (20.7)	38 (20.2)	
Department	less contaminated	77 (70.0)	165 (53.2)	.002	56 (68.3)	186 (55.0)	.0290	167 (72.0)	75 (39.9)	<.0001
	highly contaminated	33 (30.0)	145 (46.8)		26 (31.7)	152 (45.0)		65 (28.0)	113 (60.1)	
Working place	public hospital/PHC	102 (92.7)	258 (83.2)	.014	68 (82.9)	292 (86.4)	0.4210	214 (92.2)	146 (77.7)	<.0001
	private hospital	8 (7.3)	52 (16.8)		14 (17.1)	46 (13.6)		18 (7.8)	42 (22.3)	

PHC= primary health care; *For knowledge: The cut-off point over 60% as a level of goodness (joining good and moderate, modifiable from Bloom's cut-off point) and poor score if less than 60%). (Bloom *et al*., 1956) **For compliance and self-efficacy: The cut-off point of a higher score over 75 percentiles (Amin *et al*., 2013)

Table 3: Logistic regression model on the level of knowledge, compliance and self-efficacy on standard precautions

		Knowledge		Compliance		Self-efficacy	
Variables	Categories	OR (95% CI)	AOR (95% CI)	OR (95% CI)	AOR (95% CI)	OR (95% CI)	AOR (95% CI)
Age category	<30 years	2.97 (1.06-8.30)	-	1.22 (0.36-4.21)	-	0.33 (0.14-0.80)	0.34 (0.14-0.82)
	30-39 years	1.62 (0.69-3.80)	-	0.93 (0.33-2.65)	-	0.49 (0.23-1.01)	0.49 (0.24-1.03)
	>40 years	1.00000000000	-	1.00000000000	-	1.000000000000	1.000000000000
Educational Level	Diploma	1.39 (0.74-2.60)	1.71 (1.01-2.90)	1.49 (0.73-3.03)	1.91 (1.02-3.55)	3.45 (1.90-6.24)	3.47 (1.92-6.27)
	High diploma	5.21 (2.49-10.91)	5.14 (2.62-10.10)	3.06 (1.36-6.87)	3.39 (1.68-6.83)	1.54 (0.75-3.15)	1.62 (0.81-3.26)
	Bachelor and above	1.00000000000	1.000000000000	1.00000000000	1.00000000000	1.000000000000	1.000000000000
Technical title	Nurse	0.74 (0.35-1.57)	-	1.88 (0.71-4.96)	-	0.46 (0.24-0.88)	0.45 (0.23-0.88)
	practitioner nurses	0.75 (0.33-1.71)	-	2.21 (0.86-5.69)	-	0.61 (0.30-1.26)	0.61 (0.30-1.25)
	Nurse in-charge	1.00000000000	1.000000000000	1.00000000000		1.000000000000	1.000000000000
Experience	< 5 years	0.79 (0.34-1.82)	-	0.96 (0.34-2.65)	-	3.11 (1.43-6.80)	3.09 (1.42-6.73)
	5-9 years	0.46 (0.22-0.92)	-	0.65 (0.27-1.55)	-	2.59 (1.35-4.97)	2.54 (1.33-4.85)
	>10 years	1.00000000000	1.000000000000	1.00000000000	-	1.000000000000	1.000000000000
The department	highly contaminated	1.37 (0.76-2.46)	-	1.50 (0.72-3.14)	-	2.26 (1.36-3.74)	2.28 (1.38-3.78)
	less contaminated	1.00000000000	-	1.00000000000	-	1.000000000000	1.000000000000
Working place	private hospital	1.00000000000	1.000000000000	1.00000000000	-	1.000000000000	1.000000000000
	public hospital	2.07 (0.74-5.84)	2.89 (1.23-6.77)	3.41 (1.16-10.00)	1.93 (0.91-4.06)	0.30 (0.13-0.68)	0.29 (0.13-0.67)
Knowledge	Adequate			6.05 (3.41-10.75)	6.35 (3.64-11.08)	1.18 (0.71-1.96)	-
	Inadequate	-	-	1.000000000000	1.000000000000	1.000000000000	-

OR = Odds ratio; AOR = Adjusted Odds ratio; 1 = reference

Similarly, a statistically significant association was illustrated as a good level of compliance of the SP among those nurses with a bachelor's education degree and those whose technical title is nurses (p<0.001). The rest of the variables did not show any statistically significant differences.

On the other hand, three independent variables such as nurses holding bachelor's education degrees, highly contaminated departments in the health settings, and those who are working in a public hospital or primary health care settings showed a strongly statistically significant association (p<0.001) with good self-efficacy Table 2.

Factors Associated with Knowledge Compliance and Self-Efficacy

Table 3 illustrates the findings of univariate and multivariate logistic regression analysis to predict the factors associated with knowledge, compliance, and self-efficacy. Three factors have shown to be a significant predictor for the participants to have adequate knowledge of SPs the age of <30 years, those holding a bachelor's degree of nursing education, and those with 5-9 years experience or more [Odds Ratio (OR) = 2.97, 95% Confidence Interval (CI) = 1.06-8.30; OR = 5.212, 95% CI = 2.490-10.908; OR = 2.196, 95% CI = 1.082-4.457, respectively]. However, backward logistic regression analysis shows only education level, especially those who had higher diploma degrees and those working in the public health care settings to be five times more likely knowledgeable about SPs [Adjusted Odds Ratio (AOR) = 5.14, 95% CI = 2.62-10.09; AOR = 1.71, 95% CI= 1.01-2.90; AOR = 2.89, 95% CI = 1.23-6, respectively].

For measuring compliance, findings showed that a nurse holder of a high diploma had 3.06 (95% CI = 1.36-6.87) times the odds of always being compliant with standard precautions compared with those who did not. Moreover, those with adequate knowledge were found 6.05 times (95% CI = 3.41-10.75) the odds of compliance than those with inadequate knowledge. The multivariate analysis again showed that education level (diploma or higher diploma) and adequate knowledge were found to be more likely predictors of always compliance toward

standard precautions than their counterparts (AOR = 1.91, 95% CI = 1.02-3.55 and AOR = 3.39, 95% CI = 1.68-6.83, AOR = 6.35, 95% CI = 3.64-11.08, respectively).

For the self-efficacy, univariate analysis showed similarity with the multivariate findings for all the covariates, except knowledge, which showed to be more likely predictors with self-efficacy with statically significant differences. These factors were age (<30 years), education (diploma), technical title (nurses), experience (<10 years), the department related to high contamination, and the working sector (public hospital) Table 3.

Discussion

The main purpose of this study was to determine the knowledge of standard precautions among nurses in Buraidah healthcare settings in Saudi Arabia. Besides, to assess the level of compliance, self-efficacy is associated with factors related to the implementation of standard precautions.

Compliance with Standard Precautions

As far as compliance with standard precautions is the main objective of our study, our findings revealed that the majority of nurses had a high rate of good compliance (95%). This high level of SPs might be due to strong regulations to monitor the process of infection control policy and procedure in all workplaces conducted or supervised by the ministry of health in Saudi Arabia. However, the future trend seems that this process will be strengthened to get a higher compliance rate overall Saudi Arabia's healthcare facilities to cope with the policies merged in the kingdom's 2030 vision with the concern of empowering the health system and the quality of health care services (KSA. Vision2030, 2022). The recently established policies of the ministry of health in Saudi Arabia are to improve the quality of infection control in Saudi healthcare settings by empowering the infection control departments in all hospitals with no restriction for being public or private, establish and improve the "Patient Safety Culture" within healthcare organizations targeting mainly healthcare workers in all the healthcare settings in the country, increase the frequency of the continuous health education sessions such as lectures, practical demonstrations and scientific sessions and strength the level of monitoring and evaluation of the infection control procedures in all the health care settings in the country through the use of Saudi Central Board for Accreditation of Health Care Institutions (SCBAHI) accreditation as mandatory for all healthcare facilities in Saudi Arabia(CEBAHI, 2021; MOH, 2021). Our findings agreed with studies conducted among nurses in Jordan, Palestine, and India which showed that years of experience positively affect the rate of compliance toward SP (Fashafsheh *et al*., 2016; Nofal *et al*., 2017; Suchitra and Devi, 2007). Additionally, the multivariate analysis in our study illustrated that the level of education may play a role in the level of compliance with SPs. For example, an education level (diploma or higher diploma) was found to be more like a predictor of always compliant with standard precautions than their counterpart (AOR = 1.91, 95% CI = 1.02-3.55, and AOR = 3.39, 95% CI = 1.68-6.83, respectively).

On the other hand, nurses in public hospitals showed more compliance than those in private hospitals or primary healthcare facilities. This might be due to the high influence of infection control activities in public hospitals than in other healthcare facilities. These include frequent continuous health education programs such as lectures, practical demonstrations, and scientific sessions, which are not common in either private hospitals or PHC services. Another study elsewhere reported that nurse protection practices in the smaller hospitals were not as good as in the general hospitals (Efstathiou *et al*., 2011). The reason for this may be that smaller hospitals are more basic, lack good infrastructure, and have no specialized infection administration departments. By contrast, some study conducted in Saudi Arabia, Brazil, Hong Kong, and Ethiopia nurses has shown that the rate of compliance with SP reached only (23.0, 39.1, 57.4, 60, and 69.4%, respectively (Abuduxike *et al*., 2021; Asmr *et al*., 2019; Colet *et al*., 2017; Mersal and Keshk, 2016; Pereira *et al*., 2015). Moreover, some authors showed a very low rate of compliance with standard precautions among healthcare workers 19.2% (Keleb *et al*., 2023). Overall, our study showed that (92.9%) adhered strictly to the use of the standard precautions of handwashing, wearing gloves, needle use, sharp boxes, gowns, and masks.

Knowledge of the Basic SP Concepts

Nurses, among other HCWs, need to have a good knowledge of SPs as knowledge is an essential pillar for best practice and strong adherence to standard precautions. Consequently, those with a good level of knowledge in this field will help themselves and their patients from being infected as they are at risk of exposure to pathogens, contaminants, and other polluted objects in their workplace (Hessels *et al*., 2016).

In the present study, correct responses to different items related to the basic concept of SP were found high (ranging between 81.4-92.4%) for those asked about the importance of handwashing before and after any direct contact with a patient, avoiding contact and sharing personal polluted articles, managing used gloves properly, understanding the importance of the face mask, protective eyeglass, suits, caps and shoes, appropriate disposal and collection of sharp articles and also understanding the importance of caring properly for patients with such infectious diseases like tuberculosis. However, the overall

rate (73%) of correct answers for all knowledge items related to standard precaution for ns nurses was found lower than the findings in many international studies conducted among nurses (54.0 m 85, 89.0, 90.0 and 91.2%, respectively) (Abdulraheem *et al*., 2012; Asmr *et al*., 2019; Aung and Dewi, 2017; Vaz *et al*., 2010). Results indicating low knowledge levels are also in line with other studies in Saudi Arabia (Al-Dorzi *et al*., 2014; Mahfouz *et al*., 2013). However, studies from Sana'a, Yemen (Gawad, 2017), Jordan (Ghabayen *et al*., 2023), China (Luo *et al*., 2010), Ghana, Africa (Akagbo *et al*., 2017), and Tanzania (Bahegwa *et al*., 2022), have reported a low rate of knowledge of the SP (63.8, 54, 50, 37.0 and 22.5%, respectively). Moreover, our study illustrated a low level of knowledge in SP among nurses recruited from primary healthcare centers compared to those working in hospitals (23.2% versus 60.0%, data from source). This difference in knowledge could be related to different factors such as the educational characteristics of nurses in PHC and their counterparts in hospitals and differences in the frequency of training sessions focusing on healthcare personnel (CDC, 2020). When the nurses in our study were asked about the frequency and quality of training sessions they received in the last 6 months on infection prevention, only 46% of them answered positively that they received training (data from the source), which consequently could have a direct reflection on the level of nurses' knowledge in our study. Lack of resources and training opportunities and the excessive workload were the most frequent factors cited by HCWs for not implementing SPs during routine tasks. Our findings are consistent with the results from a study reported from AlHassa, Saudi Arabia, China, and India where the level of knowledge of SPs in primary health care was also showed a low level where around 50% of nurses indicated that they did not receive enough training in infection prevention (Amin and Al Wehedy, 2009; Luo *et al*., 2010; Nair *et al*., 2014).

Whether in the univariate analysis or multivariate analysis, knowledge of the standard precautions was found of great impact on the individual's compliance with the precautions. Nurses with adequate knowledge were found to have 6.05 times (95% CI = 3.41-10.75) the odds of compliance with standard precautions than those with inadequate knowledge. These findings again support that relevant education and training to improve the nurse's knowledge must place greater attention on improving the level of standard precaution practices in Saudi healthcare settings.

Self-Efficacy with Standard Precautions

Perceived self-efficacy toward compliance with the standard precautions among nurses was measured and considered as a core concept of a social cognitive theory which is about the general confidence or self-confidence showing how people could cope when they are faced with new experiences or dealing with changeable environments. The general self-efficacy rate among our nurses in this study was inadequate (44.8%) which might indicate an inadequate response about the compliance of the SP, particularly when facing a problem or certain type of trouble they might express difficulties in giving solutions. A study from Iran showed a higher rate of self-efficacy (74.8%) than what our study reported (Ghadamgahi *et al*., 2011). Though, it is suggested that the higher the self-efficacy the better the activity compliance. Self-efficacy was not tested with the level of compliance in the multivariate regression analysis; however, a strong association was found in the multivariate regression model between self-efficacy and elder aged nurses, those who are holding diplomas as education certificates, those technically titled as nurse-in-charge, experience in the work for less than 10 years, less contaminated department or section, public hospital as a site of work. In terms of the nurse working department, the self-efficacy of nurses in the less contaminated departments was lower than for those in the highly contaminated departments. This difference was found to be statistically significant ($p<0.05$) and is probably because of the greater number of chronic internal medicine and elderly patients in the medical departments. Also, there is no obvious presence of blood in the medical department, which may result in protection being neglected. Adherence to SPs is one of the strategies used to protect nurses from exposure to pathogens and to protect the patient as well and it is considered a positive impact on adherence to SP and the use of safe practices (Luo *et al*., 2010; WHO, 2004). Probably, the used cut-off of 60% for good knowledge and 75% for a good level of compliance and self-efficacy showed a variation in comparison with other studies assessing standard precaution among nurses. Hence, further study may be needed to validate the consistency of the used cut-off scores to measure adequacy in this field.

Good knowledge and a positive attitude are essential for attaining expected levels of infection control practices among critical care nurses. Thus, continuous education sessions and training are required in this field to achieve better improvement of SP measures and consequently best practices for strict adherence to ensuring good healthcare quality and an adequate safe working environment. Moreover, this study was mainly based on nurses' factors rather than healthcare system factors, therefore we did not mention those factors related to the healthcare system in the study settings. Hence, we recommend other studies to be conducted on healthcare system factors affecting compliance among HCWs. We also believe that the longer and closer observation was the best way to ensure real compliance of HCWs.

Our study showed some limitations that might restrict the generalization of the findings to all the healthcare settings at different geographical locations in Saudi Arabia. This includes among others that the described data were restricted to the healthcare settings in Buraidah city, Saudi Arabia. The recall of the events over a long time of their practice in the healthcare setting is sometimes considered among the limitations to specifying accurate information. Although the behavior of men and women is known to vary, a key variable "sex" of the participants was not included in this study and, therefore was included among the limitations of this study.

Conclusion

In this study, the general infection control knowledge and compliance to standard precautions among nurses were adequate, but not for self-efficacy. Moreover, those holding a bachelor's degree in nursing education and with 5-9 years of experience or more found more knowledge and compliance with SPs. Nurses working in primary healthcare settings and private hospitals showed fewer compliances with SPs compared to those in public hospitals. Similarly, for those working in departments with less contamination compared to those with high contamination.

From the findings from this study, it would be worth recommending the administration departments focus on comprehensive monitoring of hospitals and primary health care settings equally. Besides, provision of job-specific, infection prevention education and training to all healthcare personnel for all tasks and development to ensure that all healthcare personnel understand and are competent to adhere to infection prevention requirements as they perform their roles and responsibilities.

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Author's Contributions

Abdulaziz Mohammed Alharbi: Conceived the study and was involved in data collection and written and interpretation of data.

Amen Ahmed Bawazir: Involved in the conception, designed and data analysis and wrote the first drafted of the manuscript.

Hassan Nondo: Contributed to the edited and review of the work.

Ethics

This study was approved by the scientific committee at the level of the college of public health and health informatics and by the IRB at King Abdullah international medical research center with reference number SP18/050/R. All participants were provided with informed consent, and a brief description of the project's aim was given.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

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